FY 2009 NGGDPP PROPOSAL INFORMATION SUMMARY

Name of State Geological Survey: Office of the Massachusetts State Geologist

Project Title: Metadata for Portion of DCR Well Completion Reports

Principal Investigator:

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Component of Project Activity: Metadata

Amount Requested:

Salaries:	$
Fringe Benefits:	$
Travel Expenses:	$
Other Direct Costs:	$
Indirect Costs:	$
Grand Total:	$

Proposed Start Date: May 24, 2009

Proposed Duration: 12 months

Has this proposal been submitted to any other agency for funding: No

Active NGGDPP-related grants: No active NGGDPP awards at this time

ABSTRACT

The goal of this project is to take approximately 6800 wells located in five 7.5-minute quadrangles and create metadata for upload to the National Catalog. These 6800 records are part of a larger collection of well completion reports held by the Massachusetts Department of Recreation and Conservation (DCR) that contains 350,000 records. This collection is an indirect and derived geoscience data set that was previously entered into the online survey during a NGGDPP funded project in 2007 (P1041). This project complies with Goal #2 of the Massachusetts Long-Range Data Preservation Plan.

We recognize that preference is given to creating metadata for direct geoscience data sets such as cores and soil samples. However, at this time, none of the core and soil samples in the online survey for Massachusetts are in a position to have metadata created. The Massachusetts Water Resources Authority, which maintains some of the cores and soil samples, has not yet given approval allowing public access to their data online. MassHighway, which holds the balance of the physical geoscience data, has encountered problems with core locations that need to be resolved before metadata can be created. Unique locations for each core cannot be defined. Accordingly, the decision was made to create metadata for indirect and derived data.

The 6800 well records for which we propose to create metadata have been compiled from DCR records into well inventories for specific quadrangles. A well inventory is created for each quadrangle when a new geologic map in prepared. At this time we have prepared five new bedrock geologic maps. These include the Milford, Marlborough, Hudson, Ayer and Westford quadrangles. These five quadrangles contain approximately 6800 wells from the DCR database.

We propose to create the metadata using TKME software by manually entering the data in accordance with the standards and profile provided in the announcement. The entries will be visually checked by a second person to assure accurate transcription from the well inventory. MP or some other appropriate software will be used to check formatting and to be sure elements with restricted values are entered correctly. A random subset of these metadata will be extracted and the coordinates checked with the well inventory to be sure they plot in the correct position and that no errors were made during transcription. Finally, a random subset of 60 to 70 wells will be extracted and field checked to be sure the locations in the metadata are in agreement with the actual address and well location in the field. Metadata will be exported to the National Catalog in XML format.

Once metadata is created, these well records will be readily available through the State Geologist's web page. They will provide direct benefits to two ongoing studies by the USGS on arsenic and radionuclides. They will also benefit homeowners, consultants and well drillers working with or considering installing ground source heat pumps because these particular records provide excellent data on depth to bedrock, depth to the water table and the type and thickness of the overburden.

TABLE OF CONTENTS

INTRODUCTION

The Office of the Massachusetts State Geologist (OMSG) proposes to create metadata for the National Digital Catalog for a portion of the well completion reports that are retained by the Massachusetts Department of Conservation and Recreation (DCR). Each well drilled in Massachusetts that installs permanent casing in the ground is required to have a well completion report filed with DCR by the driller. DCR has over 350,000 well completion reports, the majority of which are paper reports stored alphabetically by town, in file boxes in the basement of the main DCR building in Boston. About 5% of these data are available electronically through an Oracle database.

We propose to take approximately 6800 of these wells in quadrangles located along the rapidly developing I-495 corridor in eastern Massachusetts and prepare the appropriate metadata for the National Catalog. The DCR well completion report collection has already been entered into the online survey during a previously funded NGGDPP project in 2007 (Collection P1041). The work proposed here is consistent with Goal #2 of the Massachusetts Long Range Data Preservation Plan.

Please note that Massachusetts has entered 13 collections in the online database. Six of these collections contain physical samples. These include four collections from the Massachusetts Water Resources Authority (MWRA) and two collections from MassHighway. We have elected to create metadata for the indirect and derived geoscience data rather than the physical geoscience data for the following reasons. The MWRA samples have to be eliminated from consideration at this time because MWRA has not yet decided whether to allow their data to be accessible to the general public online. They prefer to be contacted directly for access to the cores. They have a librarian who handles data requests and retrieval.

The MassHighway samples have serious location issues. Many of these cores are located along highway alignments and bridge structures. Unfortunately, when these data were recorded into the MassHighway database a unique location was not assigned to each core. Instead, up to 40 to 50 cores, in some cases, were assigned to the same location along the roadway baseline. Although stationing is provided for each well along with offsets left or right of the baseline, without cross referencing the stationing with the original plans, it is impossible to reconstruct a unique location for each sample. This is beyond the scope of work in this 2009 NGGDPP grant program announcement. Accordingly, we are only able to work with the indirect geoscience collections.

PURPOSE AND JUSTIFICATION

As stated above, about 95% of the 350,000 well completion reports are paper files. In order for these reports to be useful, they need to be cleansed and geocoded. This is an enormous task requiring many hours of work. As a result, the database is being updated slowly over time on an as-needed basis and as funds allow.

To help DCR remove this backlog, the OMSG has begun compiling well data on a quadrangle basis as part of its bedrock geologic and fracture characterization mapping under the National Cooperative Geologic Mapping Program.

Unfortunately, the paper logs do not have adequate locations. They usually have a lot number and a subdivision name or the address of the developer, which may be located in another town. Often the streets in these subdivisions have no names because they have not yet been dedicated to the towns at the time the wells are drilled. The data also do not have any elevation information.

To make the data set useful for our mapping projects, well completion reports are extracted from the file boxes in Boston at DCR headquarters and entered into the database. Next, the street addresses are cross referenced with subdivision lot numbers using the assessors maps in each town in consultation with the Assessor's Office or town Health Agent. This often takes many weeks to complete. Once this is done, street addresses are assigned to each well and entered into the database.

Location information is determined one of two ways. If parcel data is available in a GIS, then the street addresses are matched with parcel data and the well is placed on the centroid of the lot. If parcel data is unavailable, wellheads are located in the field by matching the street address with the posted address on the mailbox or house. This usually involves two people driving around in a car with a computer containing georeferenced, half-meter resolution orthophotos. If the well is spotted from the road it is entered on the orthophoto. If the well is not spotted it is placed next to the house on the image. XY coordinates are then extracted using a Get XY script in ArcView. Elevation data are interpolated later from the Massachusetts Digital Elevation Model. The well data is then assembled and provided as part of the bedrock geologic map digital product (Figure 1).

However, at this time there is no metadata for any of this data. Currently, we have collected data for five quadrangles in eastern Massachusetts. This includes the Milford, Marlborough, Hudson, Ayer and Westford quadrangles (Figure 2). This constitutes about 6800 wells.

The purpose of this project is to prepare metadata for approximately 6800 wells in the DCR well completion report database in compliance with the metadata profile for the National Catalog.

Preparing the metadata for inclusion into the National Catalog is justified for many reasons. First, these data are the most comprehensive and widely distributed data we have in Massachusetts and provide high quality information on water level and depth to bedrock as well as limited stratigraphic data.

Second, the area we selected to work on is located along the I-495 corridor, a circumferential highway located 25-30 miles outside of Boston, where water and energy issues are a concern due to excessive development. Communities along this belt have experienced tremendous growth. Many towns have seen up to 20% of their land area converted from an undeveloped land use classification to a developed land use in the 28-year period extending from 1971 to 1999 (Figure

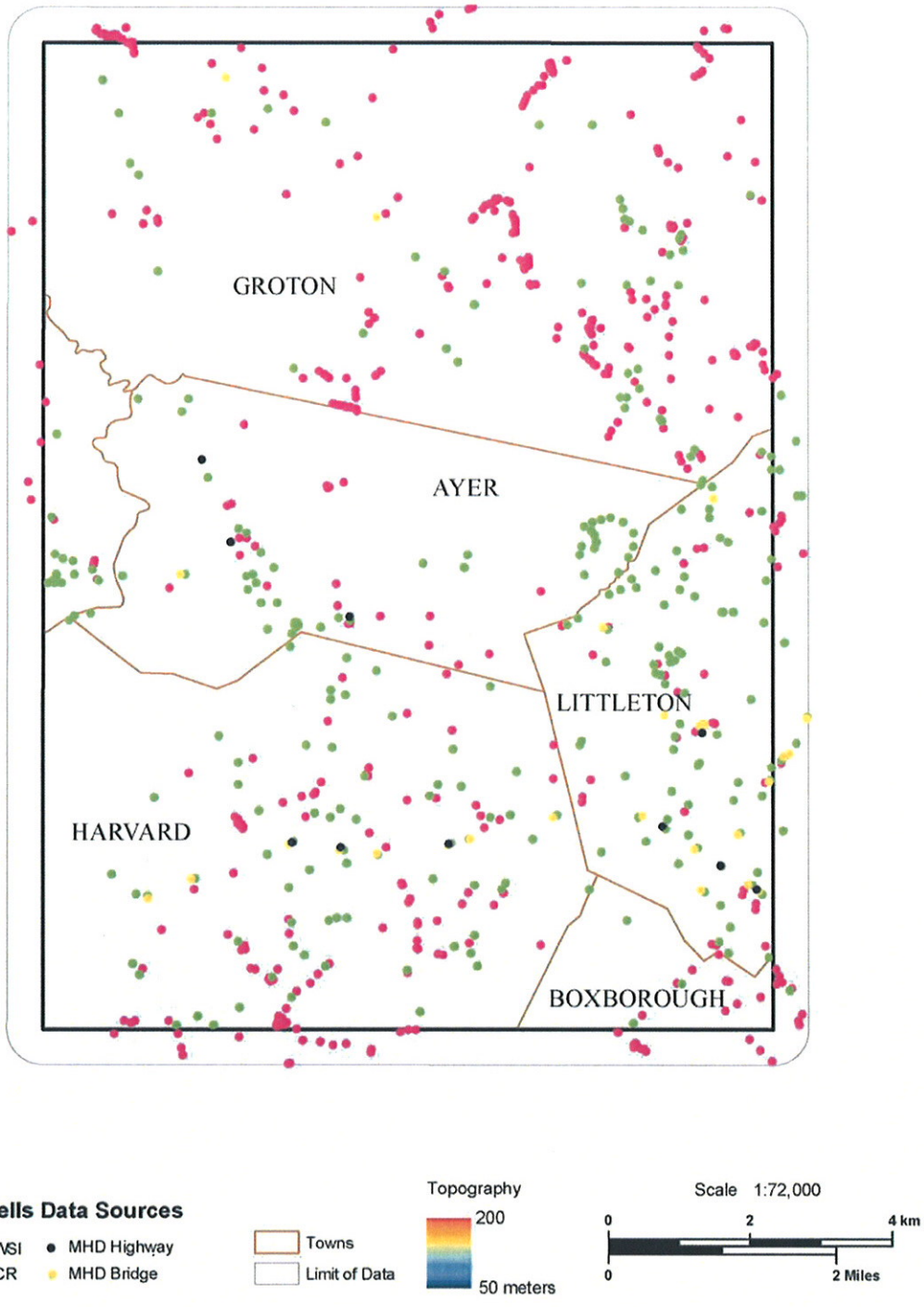

Figure 1. Example showing the well inventory compiled for the Ayer bedrock geologic map in 2006. WCR are the wells compiled from the DCR well completion report collection. Topography not shown (from Kopera et al., 2006).

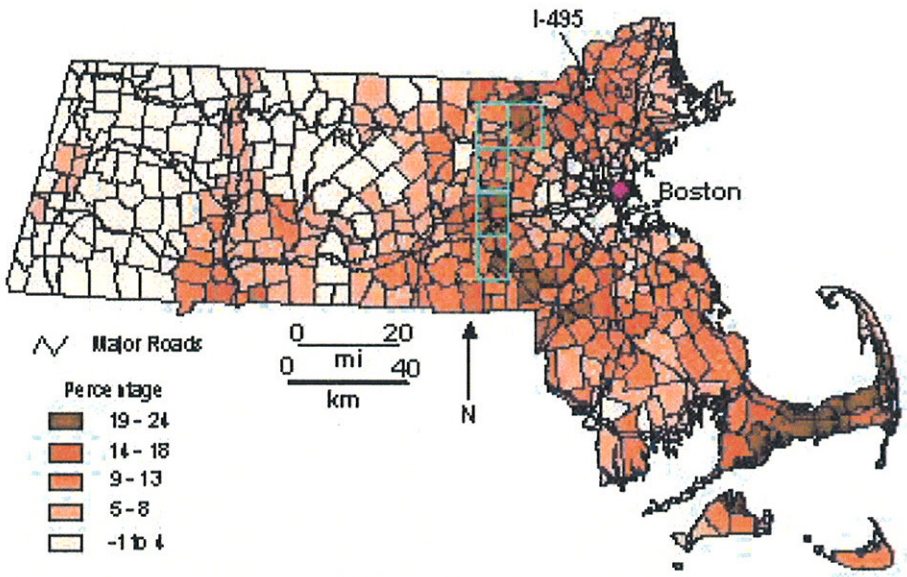

Figure 1. Map showing the percentage of land area, by town, converted from undeveloped land (crops, pastures, forests, open space) to developed land (residential, commercial, industrial land uses, etc.) from 1977 to 1999 (from MassGIS). Five quadrangles is this study shown in blue. From NE to SW: Westford, Ayer, Hudson, Marlborough and Milford.

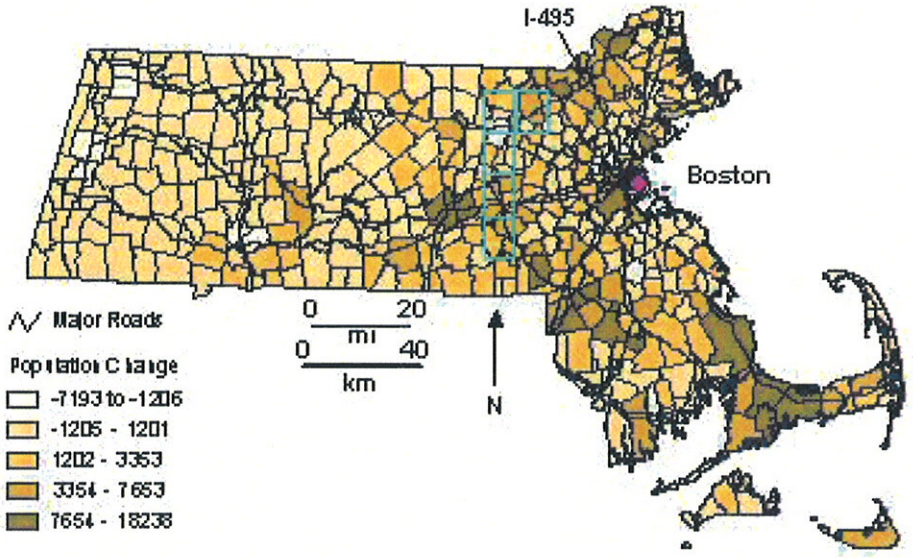

Figure 2. Population change in Massachusetts from 1980 to 2000 by town (based on census data available from MassGIS). Quadrangles mentioned in text shown in blue.

2). The populations of some towns have increased by as much as 50% in the period extending from 1980 to 2000 (Figure 3).

Third, there is increasing interest at the state level to determine the distribution of both arsenic and radionuclides in well water across the state and to relate this to geologic map units. No statewide assessments of arsenic or radionuclides distribution have been performed. However, it is well known that naturally occurring arsenic occurs with high frequency in this area of Massachusetts specifically in the Paxton, Oakdale and Berwick formations. This region is often referred to in Massachusetts as the "Arsenic Belt" but extends from Connecticut up into Maine (Figure 4). Concentrations of arsenic in groundwater in excess of 20 μg/L occur in the vicinity (Ayotte et al., 2003). Some towns are very concerned about this issue.

In the next year, the USGS will be commencing a statewide arsenic study to be funded by the Massachusetts Department of Environmental Protection. Part of their work will be to correlate arsenic levels to bedrock units. The availability of new well information that can be readily available from the OMSG website will be helpful to that study because the wells we are proposing to work on are situated in or near the arsenic belt (Figure 4).

Fourth, the USGS is also commencing a regional study of the factors related to well yield in the fractured-bedrock aquifers of the Nashoba terrane. The scope of the study will follow closely the statistical approach used by the USGS in New Hampshire (Moore et al., 2002) to map the probability of achieving high yields in bedrock aquifers. Detailed, 1:24,000-scale bedrock mapping and brittle structural data are used in the multivariate linear regression model. Well yield is the dependent variable in the regression. One of the first activities in this study will be to assemble a well inventory. Access to the wells in the DCR database will help this USGS project. Most of the wells in the quadrangles for which we propose to prepare metadata, are located within the Nashoba terrane (Figure 5).

Finally, the main benefactors of this proposed project will be those homeowners, consultants and well drillers working with or considering installing ground source heat pumps. The number of ground source heat pump systems installed in Massachusetts tripled in the last year and it is the only activity keeping many well drillers in business in the current economy. The information these folks need to design properly a heat pump system is the depth to bedrock, depth to the water table and the type and thickness of the overburden. The DCR well data will also furnish this data in an area that is experiencing significant growth and development and will allow well drillers to estimate costs more precisely.

In 2007, there were over 150 requests for access to information in the DCR collection for real estate, teaching, engineering projects and water resource management purposes. This is without the information being available online. With the preparation of metadata for a portion of the DCR wells and the availability of this information through the OMSG web page, we believe interest in these data will increase substantially.

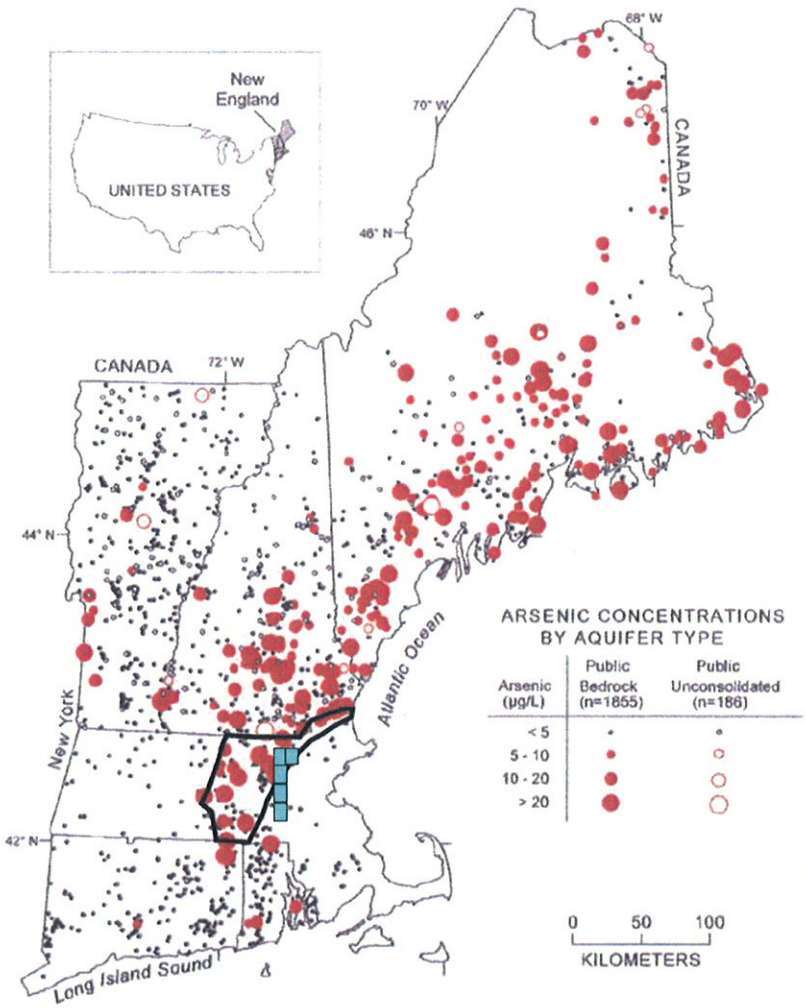

Figure 4. Distribution of arsenic in source waters to New England public supplies by aquifer type, modified from Ayotte et al. (2003). Bold black line indicates the Massachusetts arsenic belt. Cyan rectangles represent approximate location of quadrangles discussed in text..

STRATEGY FOR DATA PRESERVATION

A long-range data preservation plan is available in draft form and is awaiting final review and approval from the MA Data Preservation subcommittee. The process of developing the long range plan for Massachusetts is as follows. In August 2008, the need to develop a long range plan was brought forward to the State Mapping Advisory Committee (SMAC). This committee was established as part of the National Cooperative Geologic Mapping program and meets once a year. Since most of the members of the SMAC are also affiliated with the agencies that collect and hold the majority of the physical and indirect collections, we decided to form a data preservation subcommittee from this group. The members of the subcommittee and their affiliations are listed in Table 1.

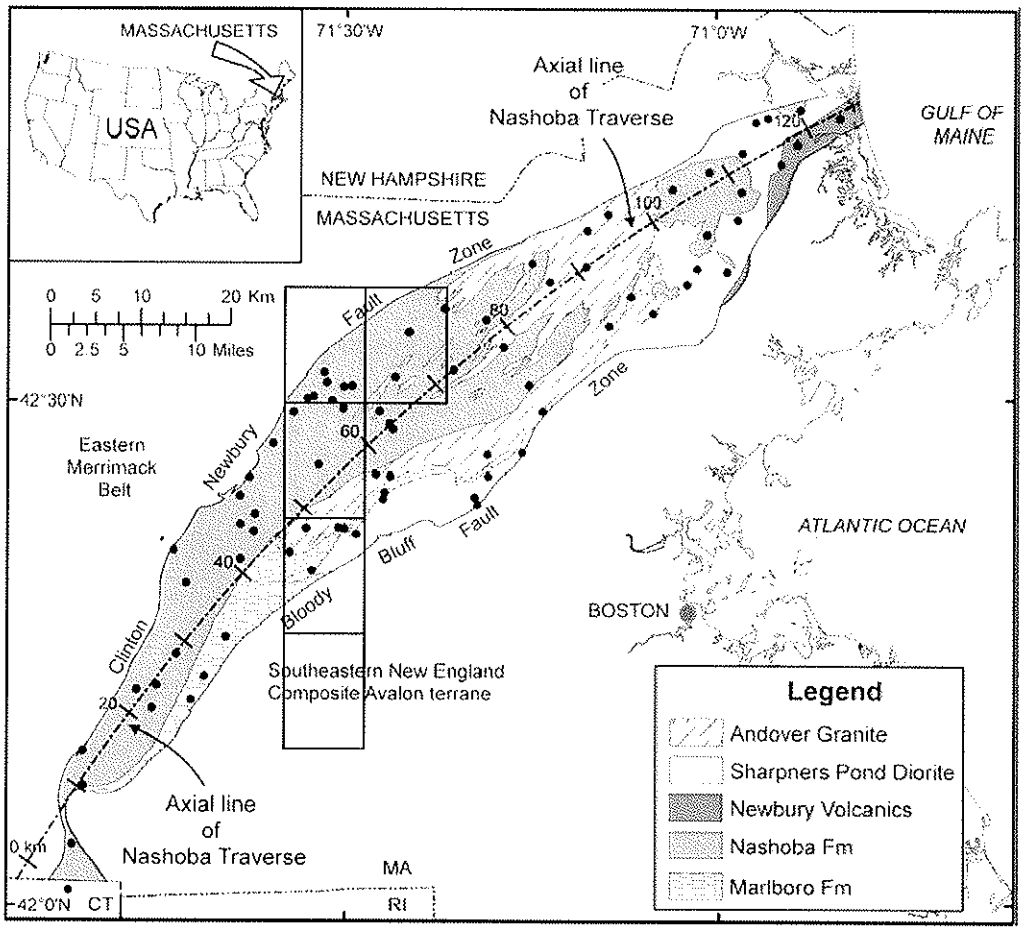

Figure 5. Generalized geologic map of the Nashoba terrane (from Manda et al., 2008). Solid circles are outcrop fracture stations. Rectangles show the location of quadrangles having the well data from the DCR well completion report collection. From NE to SW: Westford, Ayer, Hudson, Marlborough and Milford quadrangles.

Table 1. Members of the Massachusetts Data Preservation Subcommittee

Member	**Affiliation**
Bill Levy	MA Water Resources Authority
Laurene Poland	Director, MA Well Driller's Registration Program
Nabil Hourani	State Geotechnical Engineer, MassHighway
Peter Weiskel	Associate Director, U.S. Geological Survey
Steve Mabee	MA State Geologist

A plan was written and will be reviewed by this group and approved by the SMAC at the next annual meeting in August 2009.

There are two major goals to the plan. 1) Find a new home for the MWRA core repository. This collection of more than 50,000 feet of core was recently in peril of being disposed of and buried in a deep construction shaft. Fortunately, the collection was saved. However, it was moved from its existing environmentally friendly storage facility and scattered among four separate storage areas throughout eastern Massachusetts that have less than ideal environmental conditions. It is a high priority to find a new, centralized home for the collection but this will require a substantial investment that is not likely to occur in the near term. 2) Remove the backlog from DCR well completion reports and enter the data into an electronic database. The DCR collection consists of 350,000 records and is the most comprehensive resource available in Massachusetts yet only 5% is easily accessed by the public. This proposal supports Goal # 2 of the Data Preservation plan and will make 6800 more wells (another 2 %) available to the public.

Work Flow Tasks

The work will progress as follows.

Task 1 - Data Entry - We will prepare metadata for 6800 well sites that have been compiled from the DCR database (Collection ID P1041) as part of our NCGMP STATEMAP mapping efforts. Metadata will be created and edited using TKME software following the template provided (http://datapreservation.usgs.gov/docs/NGGDPPMetadataProfile.pdf). TKME is the software used to create FDGC compliant metadata for our bedrock geologic maps. Data will be transcribed from our well inventory files by one member of the team.

Task 2 – Quality Control/Quality Assurance – There will be four levels of QA/QC for this project. First, a second member of the team will manually review the data entry to be sure information was transcribed correctly. Once reviewed we will use MP (Metadata Parser), if appropriate, or some other suitable program to check the formatting and also to be sure elements with restricted values are entered correctly. This may require customizing the config sys files to match the data preservation metadata profile. The output format will be XML. Third, we will randomly select 1% of the data and extract the geographic locations of the wells and visually compare their locations with the locations shown in our well inventory. We will correct any errors found. Finally, we will randomly select 60 to 70 wells from the database and spend one week of field time physically matching the records with the well location in the field. We expect better than 99% accuracy that the coordinates in the data base will match the correct house, owner and well in the field.

Long-Term Maintenance and Updating

In 2006, the well reporting requirements for Massachusetts well drillers were upgraded substantially. Improvements were made to how well drillers described soil and rock and GPS locations are now required for all wells. In addition, a new online data entry form was created in Massachusetts allowing well drillers to input data directly into the DCR database. These changes went into effect on July 1, 2007. A series of training workshops led by the OMSG with help from DCR and the MA Department of Environmental Protection trained the well drillers in how to use the new online data entry system and provided training on how to use GPS. Only

those well drillers who have gone through training are allowed to use the online data entry system but all drillers are required to use GPS for well locations.

As a result, all wells drilled after July 1, 2007 are entered directly into the DCR database. There is no more backlogging of new, incoming wells. Therefore, updating the DCR well completion collection will be much easier in the future.

Accordingly, the national catalog can be updated annually by extracting from the DCR database those new wells drilled in any one of the five quadrangles covered in this proposal. This can be done by the OMSG in consultation with DCR and should involve fewer than 100 or so wells per year. At the present time, the well data for the five quadrangles are current through 2004 to 2008 (date of publication of the geologic map). The data set reference date will provide the currency of the entry.

PRELIMINARY RESULTS AND PRIOR WORK

A NGGDPP grant was awarded to the OMSG in 2007. Thirteen collections representing four agencies were entered into the online survey as part of a Phase 1 project. This represents 81,680 linear feet of core, 79,000 soil samples, 530,000 well logs, and 525 rock samples and thin sections.

The only other prior data preservation work performed by the OMSG was saving the 70,000 or so linear feet of rock core in the MWRA collection. MWRA staff contacted the OMSG surreptitiously because there were rumors MWRA management wanted to dispose of the cores down a construction shaft. The OMSG created a Core Repository Advisory Committee (CRAC) and set about saving the core from destruction. We testified before the Records Conservation Board to remind the Board that cores are considered public records and that they have a permanent retention schedule. These records can not be disposed unilaterally without due process. Eventually we helped MWRA find a new home for the core but the collection was split up by contract number and relocated into four widely separated locations. The MWRA would like to relinquish all responsibility for maintaining and housing the core. The entire data preservation odyssey can be found by visiting the state geologist's web page (http://www.geo.umass.edu/stategeologist) and following the link on the home page for "Save the Core". The Executive Summary and Position Paper can be found there.

PRODUCTS/REPORTS

The final deliverable will be metadata in XML format for approximately 6800 wells, which represent a portion of the DCR well completion report collection (P1041).

PROJECT PERSONNEL

Stephen B. Mabee, MA State Geologist, will be the Principal Investigator. He will oversee the management of the project, provide the QA/QC in task 2 above, participate in the field verification and review the final report. Dr. Mabee's time will be donated and provided as the match for the project. Dr. Mabee will materially participate in the project. He has experience

working with metadata creation on a recent FEMA Map Modernization project for Hampden County MA. This work involved creating metadata with Metaman in accordance with FDGC and FEMA standards. Data provided were in XML format and were created for three profiles, DFIRM, Basemap and Orthoimagery.

Dr. Steve Nathan, is a post-doc/research fellow that has been working with the State Geologist's office for several years on many projects. His most recent project was the FEMA map modernization project mentioned above. He was responsible for digitizing, feature attribution, editing of DFIRM panels, and metadata. The work was completed in GIS using customized tools through the FEMA Map Information Platform. Funds are requested for Dr. Nathan's time.

REFERENCES CITED

Ayotte, J.D., Montgomery, D.L., Flanagan, S.M., and Robinson, K.W., 2003, Arsenic in groundwater in eastern New England: Occurrence, controls, and human health implications: Environmental Science and Technology, vol. 37, pp. 2075-2083.

Kopera, J.P., S.B. Mabee and D.C. Powers. 2006. Preliminary fracture characterization map of the Ayer quadrangle, Massachusetts. Office of the Massachusetts State Geologist, Open File Report 06-03, 4 sheets.

Manda, A.K., S.B. Mabee and D.U. Wise. 2008. Influence of rock fabric on fracture attribute distribution and implications for groundwater flow in the Nashoba terrane, eastern Massachusetts. Journal of Structural Geology, v.30, pp.464-477.

Moore, R.B., Schwarz, G.E., Clark, S.F., Jr., Walsh, G.J., and Degnan, J.R., 2002, Factors related to well yield in the fractured-bedrock aquifer of New Hampshire: U.S. Geological Survey Professional Paper 1660, 51 p.

NATIONAL GEOLOGICAL AND GEOPHYSICAL DATA PRESERVATION PROGRAM
FY 2009 DETAILED BUDGET ESTIMATES

STATE: MASSACHUSETTS

PROPOSAL SHORT TITLE: Metadata for Portion of DCR Well Completion Reports

Budget Category	Federal Funding Requested	Matching Funds Proposed
SALARIES:		
Geologist: Mabee (PI) - provide QA/QC of metadata,	$	$
field verification of data, supervise completion of work,		
review final report		
Rate is per week x 3.7 weeks		
Geologist: Nathan (Post-Doc) - prepare data, enter data	$	$
for creation of metadata, field verification of data		
prepare final report		
Rate is per hour x 40 hours/week x 6 weeks		
FRINGE BENEFITS: (see note below)		
Mabee		$
Nathan	$	
FIELD EXPENSES:		
Per Diem		
Lodging		
Vehicle Cost		
Mileage: Travel for Mabee & Nathan (mi x		
)		
(see note below)		
WORKSHOP TRAVEL EXPENSES		
Nathan, Geologist, metadata creator		
Per Diem (/day x 2 days)		
Lodging (2 nights x)		
Transportation Costs (shuttle to/from Indianapolis Airport)		
Registration		
OTHER DIRECT EXPENSES:		
Base Maps, field books, photos		
Field Supplies		
TOTAL DIRECT COST:		
INDIRECT COST (57%)		
(see negotiated rate agreement)		
INDIVIDUAL PROJECT TOTAL:		
Fringe for Mabee is cluding Worker Comp., Unemployment, Universal Health, Medicare tax		
per week Health and Welfare, 0.2% for Sick Leave Bank		
Fringe for PostDoc is workers comp, unemployment, Universal Health, Medicare tax		
Travel - Mileage reimbursement rate set by University. Includes 5 trips to I-495 area to do random check		
on well locations. Includes 5 trips to sites in the Westford, Milford, Marlborough, Hudson and Ayer		
quadrangles. Average roundtrip mileage is 175 mi x		

BUDGET EXPLANATION

Salaries

The University pays its faculty and staff on a salary base in accordance with OMB Circular A-21. Any weekly or hourly rate stated is for information purposes only and not subject to audit.

Mabee, State Geologist - The University of Massachusetts pays the salary of the State Geologist. For the proposed project, the state geologist will be actively involved in the performance of the technical work. This includes all coordination of the work, performing visual quality control and quality assurance on each record entered in the metadata, participating in field work to verify locations of a subset of the wells in the data base for which we will be creating metadata, and reviewing the final report. All time spent on this project by the State Geologist will be used as match against the federal funds. The state geologist will be contributing approximately 3.7 weeks of time to the project. This includes 1 week in the field for field verification of data entries.

Nathan, Geologist, PostDoc – Steve Nathan is a Geologist/GIS specialist that has worked with the Office of the State Geologist for several years and has worked on many projects. He has worked with the office in the capacity as a postdoctoral fellow. We are requesting federal funds to support Dr. Nathan's salary, fringe and participation in the Data Preservation Workshop in Indianapolis. The hourly rate for the postdoc position is $ per hour. Dr. Nathan will work six weeks on the project. Dr. Nathan will prepare the data, create the metadata, participate in the field verification and prepare the final report.

Fringe Benefits

Fringe benefits for the state geologist are determined as follows: including worker compensation, unemployment, universal health and Medicare; per week for health and welfare; and, for Sick Leave Bank. Fringe for the Postdoc is for worker compensation, unemployment, Universal Health and Medicare.

Field Expenses

Per diem is $40 per day and the mileage rate is per mile and is set by the University. All staff doing field work use personal vehicles. Funds are requested to conduct field work for one week to do a random field check on a subset of wells extracted from the database to be sure the data entered for the metadata match the correct address in the field. We estimate daily roundtrip travel to and from the field to be 175 miles for 5 days times per mile for a total of

Data Preservation Workshop - For this workshop, we are requesting funds for the registration ( ), ground travel ( )), lodging (r night x 2 nights) and per diem (y x 2 days) for Dr. Nathan. Note: The University does not allow any cost sharing on travel.

State Match

The majority of the state match for projects that require a 1:1 match must come from a donation of Dr. Mabee's time to the project. For this proposal, Dr. Mabee will materially and actively participate in the actual technical work of the project, see above. The cost share from Dr. Mabee includes salary, fringe and the indirect cost applied to his salary and fringe.

Indirect Cost Calculations

The negotiated rate agreement for federal sponsored research is Indirect costs are allowed for the time contributed by the State Geologist.

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Amherst, MA 01003

EDUCATION

University of Massachusetts, Ph.D, Geology, 1992, Dissertation: "Lineaments: Their Value in Assessing Groundwater Availability and Quality in Bedrock Aquifers of Glaciated Metamorphic Terrains - A Case Study"
University of Colorado, M.S., Geology, 1978, Thesis: "The Use of Magnetite Alteration as a Relative Age Dating Technique: Preliminary Results"
Tufts University, B.S., Geology (Magna Cum Laude), 1974

PROFESSIONAL EXPERIENCE

University of Massachusetts, State Geologist, Dept. of Geosciences, 2002 - present
University of Massachusetts, Assistant Professor, Dept. of Geosciences, 1995 - 2002.
Amherst College, Visiting Assistant Professor, Dept. of Geology, 1992-1995.
Sasaki Associates, Inc., Watertown, MA, Senior Associate/Project Geologist, 1979-1986.
R.V. Lord and Associates, Inc., Boulder, CO, Field Geologist/Lab Manager, 1977-1979.

PROFESSIONAL AFFILIATIONS

Geological Society of America
American Geophysical Union
Association of American State Geologists
National Ground Water Association

PROFESSIONAL REGISTRATIONS

Professional Geologist Maine, New Hampshire, North Carolina

SELECTED PUBLICATIONS

Manda, A.K., S.B. Mabee and D.U. Wise. 2008. Influence of rock fabric on fracture attribute distribution and implications for groundwater flow in the Nashoba terrane, eastern Massachusetts. Journal of Structural Geology, v.30, pp.464-477.

Mabee, S.B. 2005. Fracture characterization map of the Hudson quadrangle, Massachusetts. Massachusetts Geological Survey, OFR 06-02a, 5 sheets.

Mabee, S.B. and S. Salamoff. 2004. Fracture characterization map of the Marborough quadrangle, Massachusetts. Massachusetts Geological Survey, OFR 06-01b, 5 sheets.

Mabee, S.B., P.J. Curry and K.C. Hardcastle. 2002. Correlation of lineaments to groundwater inflows in a bedrock tunnel. *Ground Water*, v.40, no.1, pp. 37-43.

Mabee, S.B. 1999. Factors influencing well productivity in glaciated metamorphic rocks. *Ground Water*, v.37, no.1, pp.88-97.

Mabee, S.B. and K.C. Hardcastle. 1997. Analyzing outcrop-scale fracture features to supplement investigations of bedrock aquifers. *Hydrogeology Journal*, v.5, no.4, pp.21-36.

Mabee, S.B., K.C. Hardcastle, and D.U. Wise. 1994. A method of collecting and analyzing lineaments for regional-scale fractured-bedrock aquifer studies. *Ground Water*, v.32, pp.884-894.

SYNERGISTIC ACTIVITIES

- Designed and developed a new fracture characterization map to augment traditional bedrock geologic maps; maps are used by the engineering community and public agencies.
- Designed a new standardized coding system for soil and rock descriptions in Massachusetts and trained over 340 water well drillers in how to use the new coding system as well as utilize GPS technology for locating wells; work completed to improve the quality of subsurface data for use by researchers and the engineering community.
- Designed and implemented with other public agencies a new online data entry system and database for subsurface data; will permit instantaneous access to subsurface data.
- FEMA, Map Modernization Program, Project Manager for DFIRM production of 168 panels in Hampden County, Massachusetts, includes metadata production.

GRANT SUPPORT

Received 14 grants and contracts in past five years as State Geologist totaling $908,000; 70% from federal sources, 30% from state and other sources; about 60% is for geologic mapping

COLLABORATORS

Byron Stone, U.S. Geological Survey
Scott Salamoff, Colorado State University
Joe Kopera, University of Massachusetts
Chris Condit, University of Massachusetts
Alex Manda, University of Massachusetts
Donald Wise, University of Massachusetts

STUDENTS ADVISED DURING PAST FIVE YEARS:

Thesis Advisor: Patrick Curry (M.S.)
Kit Williams (M.S.)
Janna Levin (M.S.)
Alex Manda (Ph.D.)
Total Number of Graduate Students Advised: 3 Ph.D; 8 M.S.

GRADUATE ADVISORS

Dr. Richard F. Yuretich, University of Massachusetts
Dr. Donald U. Wise, University of Massachusetts (emeritus)

STEPHEN A. NATHAN

113 Church Street, Ware, MA 01082 (413) 967-5448 snathan@geo.umass.edu

Summary

- Experienced and effective geologist, communicator, and project manager.
- Proven ability to quickly become an expert with new projects. Creative, detail-oriented, and goal driven.
- Works productively in teams or independently. Effectively manages multiple projects and meets deadlines.

Professional and Research Experience (recent)

Office of the State Geologist, Univ. of Massachusetts, Postdoctoral Research Associate **2005 - Present**

-My postdoctoral work encompasses three separate projects:

1) FEMA Map Modernization project (U.S. Department of Homeland Security) for Hampden County, Massachusetts. Use ArcMap GIS to digitize, attribute, and edit DFIRM map panels of flood hazards within the county, and create project metadata in accordance with FDGC and FEMA standards.

2) Build a digital, 3-dimensional subsurface map of the Marlborough quadrangle in Massachusetts. Interpreted and correlated borehole data; created the map using the geologic software RockWorks.

3) Examine marine microfossils (i.e., benthic foraminifera) from the Merrimack River Delta, Gulf of Maine, to better assess offshore sand and gravel resources. I produced a report of my findings for the project proponent: Minerals Management Service, U.S. Department of Interior.

University of Massachusetts Amherst, Dept. of Geosciences, Research Assistant **2002 - 2005**

- My dissertation examined the South China Sea and western Pacific Ocean to document water mass changes during the Late Miocene (13-5 million years ago). I accomplished this by studying microfossil (i.e., planktic foraminifera) populations and their stable isotopes (δC^{13} and δO^{18}).

BP (formerly British Petroleum), Houston, TX, **Biostratigraphy Summer Intern** **2004**

-Summer project: Identify and compare the benthic foraminiferal assemblages found within Gulf of Mexico core samples to the assemblages found within well cuttings collected from the same site. My research was combined with similar microfossil studies to assist with reservoir characterization.

Science, Technology, Engineering and Mathematics Teacher Education Collaborative (STEMTEC), University of Massachusetts Amherst, MA, STEMTEC **Program Assistant** **1995 - 2002**

-Assisted with drafting the NSF STEMTEC proposal (proposal successfully awarded for $5 million).

-Coordinated logistical details of STEMTEC conferences, workshops, seminars, and programs.

Ocean Drilling Program, Leg 184 South China Sea, **Biostratigrapher/Shipboard Scientist** **Spring 1999**

-Analyzed deep sea sediment cores recovered during Leg 184, contributed to biostratigraphy site reports.

-Biostratigraphy section editor for the Leg 184 Initial Reports volume (see "Publications").

Massachusetts Department of Environmental Protection, Biochemist (Project Officer) **1987 - 1992**

-Managed 12 environmental construction projects and feasibility studies for the Clean Lakes Program.

-Conducted field surveys to assess the water quality of Massachusetts water-bodies as well as post-construction water quality monitoring programs of water-bodies restored by the Department.

Computer Skills

Experienced user of PC, Macintosh, and Unix operating systems and software such as:

- ArcMap GIS, Metaman
- Adobe Photoshop, Illustrator, CorelDraw, SigmaPlot and other graphics software
- Microsoft Word, Excel, PowerPoint
- RockWare (geologic software)

STEPHEN A. NATHAN 413-967-5448 snathan@geo.umass.edu

Academic Degrees

Ph.D.	**Geosciences**, University of Massachusetts Amherst (R. Mark Leckie, Ph.D., advisor)	**2005**
M.S.	**Geology**, University of Massachusetts Amherst	**1999**
B.S.	**Physics**, University of Massachusetts Amherst	**1995**
B.S.	**Biology**, Springfield College, Springfield, MA	**1980**

Teaching and Presentation Experience (recent)

University of Massachusetts, Department of Geosciences, Amherst, MA, **Instructor** **Fall 2006**
-Taught Geology 445 - "Sedimentology", lecture and laboratory.

Holyoke & Greenfield Community Colleges, Adjunct Instructor of Geology and Chemistry **2005 - 2006**
-Taught ESC 120 - "Introduction to Geology" and Chemistry 105 - "Basic Principles of Chemistry".

Smith College, Northampton, MA, **Visiting Lecturer in Geology** **Spring 2003**
-Taught Geology 109 - "The Environment".

Mount Holyoke College, South Hadley, MA, **Visiting Instructor in Geology** **Spring 2002**
-Taught Geology 324 - "Sedimentology and Stratigraphy", lecture and laboratory.

Grants and Awards

Society for Sedimentary Geology, North American Micropaleontological Section, Mobil Travel Grant **2003**
Geological Society of America, Graduate Student Research Grant **2000, 2002**
University of Massachusetts Amherst, Dept. of Geosciences, Gloria Radke Memorial Prize, **2002**
University of Massachusetts Amherst, Dept. of Geosciences, Elinor I. Fierman Prize **1999, 2000, 2001**
Geological Society of America, Harold T. Stearns Fellowship Award **2001**
American Association of Petroleum Geologists, Grants-in-Aid Research Award **2000**
Cushman Foundation for Foraminiferal Research, William V. Sliter Student Research Award **1999, 2000**
Sigma Xi, Grants-in-Aid Research Award **April 2000, October 2000**
National Science Foundation, Research Experience for Undergraduates Award **1993 & 1994**

Publications

Nathan, Stephen A. and Leckie, R.M., 2009. Closure of the Indonesian Seaway and ocean circulation during the middle to late Miocene (~13.2-5.7 Ma): early history of the Western Pacific Warm Pool, (accepted for publication to Palaeogeography, Palaeoclimatology, Palaeoecology).

Nathan, Stephen A. and Leckie, R.M., 2003. Miocene Planktic Foraminiferal Biostratigraphy of Sites 1143 and 1146, ODP Leg 184, South China Sea. *Proceedings of the Ocean Drilling Program, Scientific Results, 184*. Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547. http://www-odp.tamu.edu/publications/184_SR/184TOC.HTM

Wang, P., Prell, W.L., Blum, P., et al., 2000. *Proceedings of the Ocean Drilling Program, Initial Reports, 184*. Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547.

Professional Memberships

American Association of Petroleum Geologists Geological Society of America

References

Stephen B. Mabee, Ph.D., P.G., State Geologist (Massachusetts)	413-545-4814, sbmabee@geo.umass.edu
R. Mark Leckie, Ph.D., Professor, University of Massachusetts	413-545-1948, mleckie@geo.umass.edu
Laurie Brown, Ph.D., Professor, University of Massachusetts	413-545-0245, lbrown@geo.umass.edu